

May 1996

Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal Engineering Research Center
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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

These reports are now available via the World Wide Web at
<http://frf.wes.army.mil/frf.html>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and criticisms are welcome.

Introduction

1

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511 (*c.baron@cerc.wes.army.mil*).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

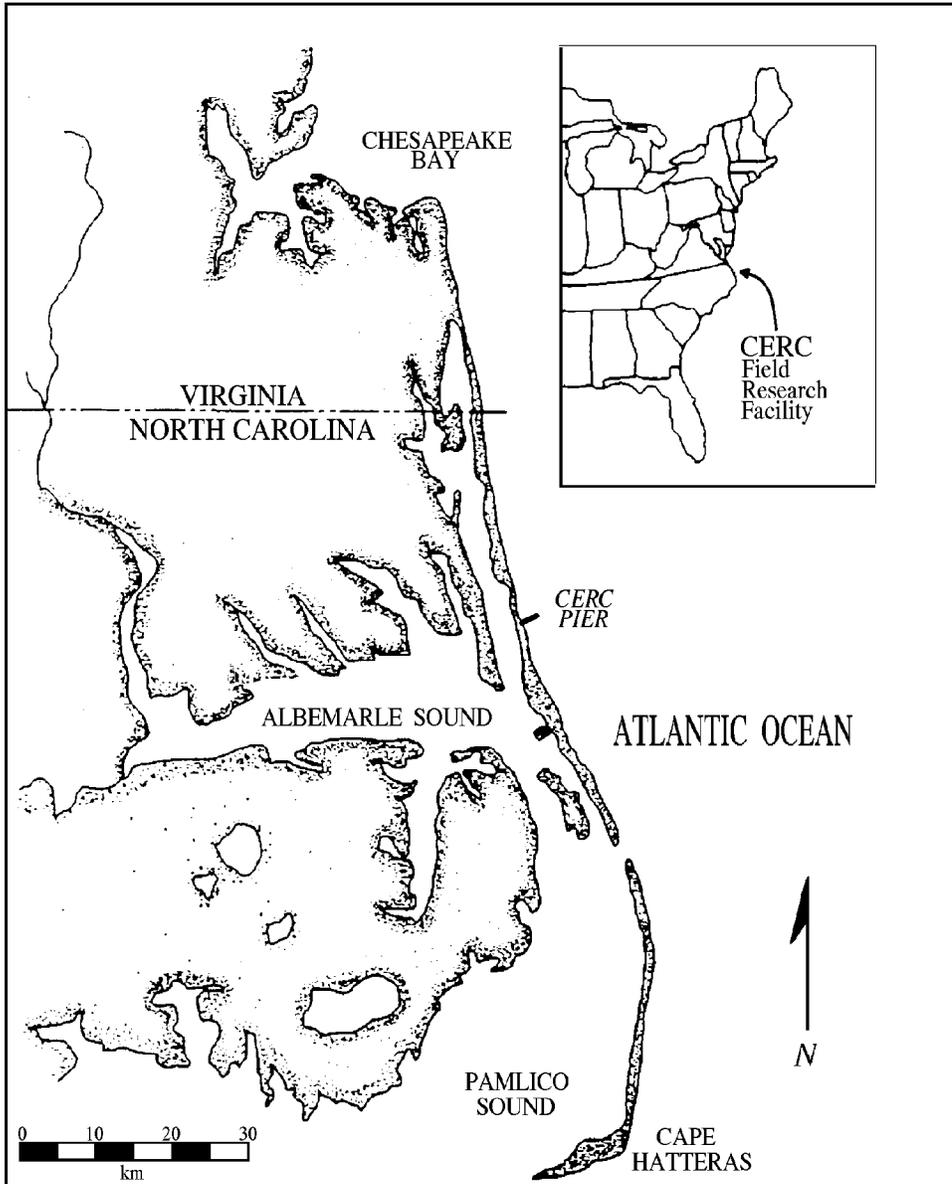


Figure 1. FRF Location Map

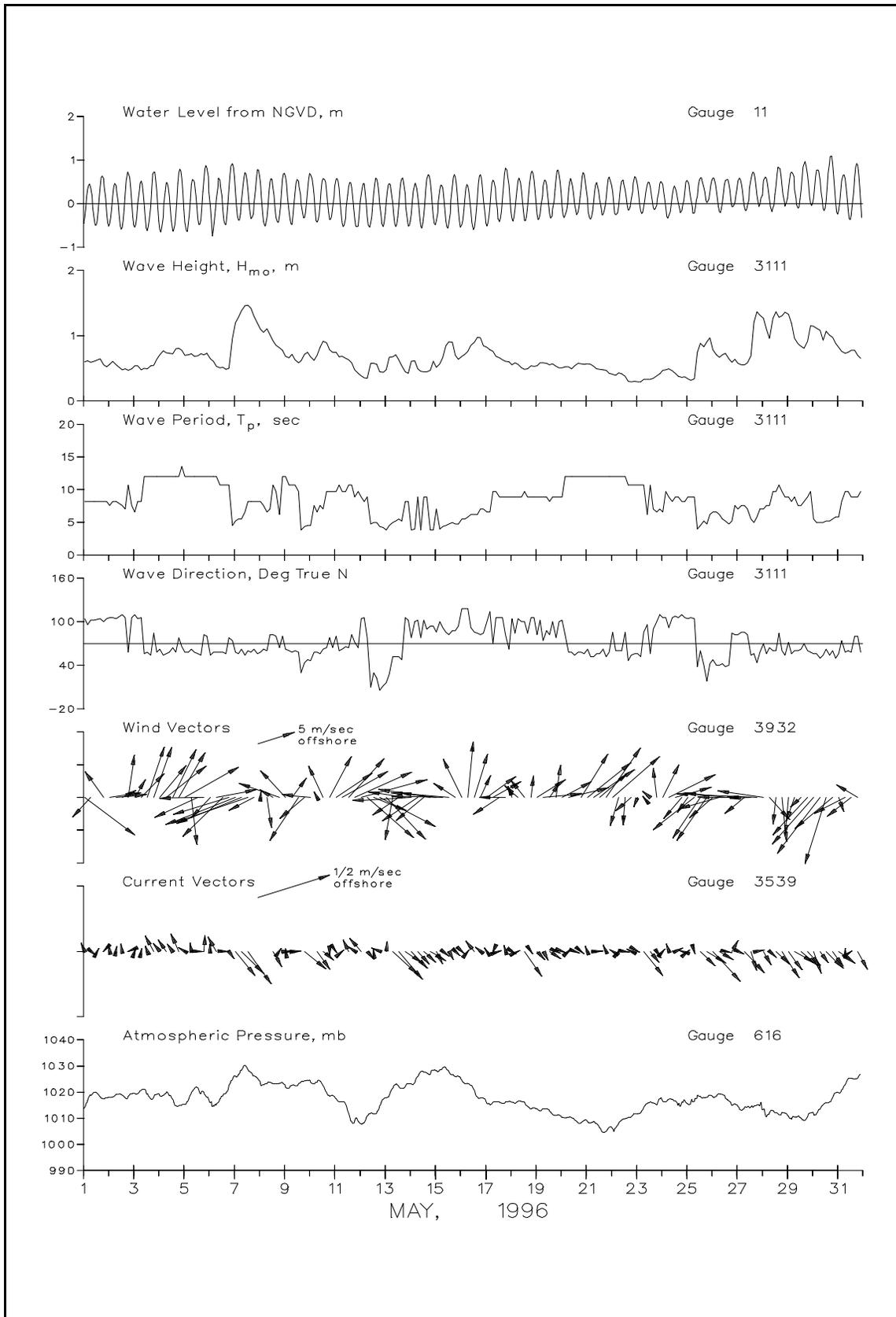


Figure 2. Month at a Glance

**Table 1
Instrument Status/Data Availability**

		May 1996																																			
		Day of the month																																			
Gauge ID	Description/Remarks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	/	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	/	*	*	*	*	*	*	*	*				
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
625	Baylor staff on FRF pier	Gauge Status	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
		Data Collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	/	/	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*				
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
	Visual Observations (daily oceanographic and meteorological observations)	Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
Gauge Status		*	=	Operational	/	=	Partial	-	=	Non-Operational																											
Data Collected		*	=	All	/	=	Partial	-	=	None																											
Visual Observations		*	=	Complete	/	=	Partial	-	=	None																											

**Table 2
Gauge Locations**

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates *Crossshore m	Longshore m	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Atmospheric Pressure	36 10' 57.03"	75 45' 5.50"	11.60	569.00	----	----
3932	Anemometer	36 11' 1.23"	75 44' 43.07"	585.20	517.30	19.50	----
641	Pressure Gauge	36 10' 57.71"	75 44' 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11' 1.04"	75 44' 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11' 19.14"	75 44' 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11' 11.28"	75 44' 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11' 13.70"	75 44' 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11' 12.48"	75 44' 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11' 14.06"	75 44' 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10' 5.10"	75 41' 59.30"	3934.96	-2400.81	Surface	-17.00
3539	Current Meter	36 11' 23.57"	75 44' 9.12"	1605.80	907.60	-11.60	-11.70
11	NOAA Tide Gauge	36 11' 1.25"	75 44' 42.60"	596.49	514.20	Surface	-7.62
R		R	R	R	R	R	R

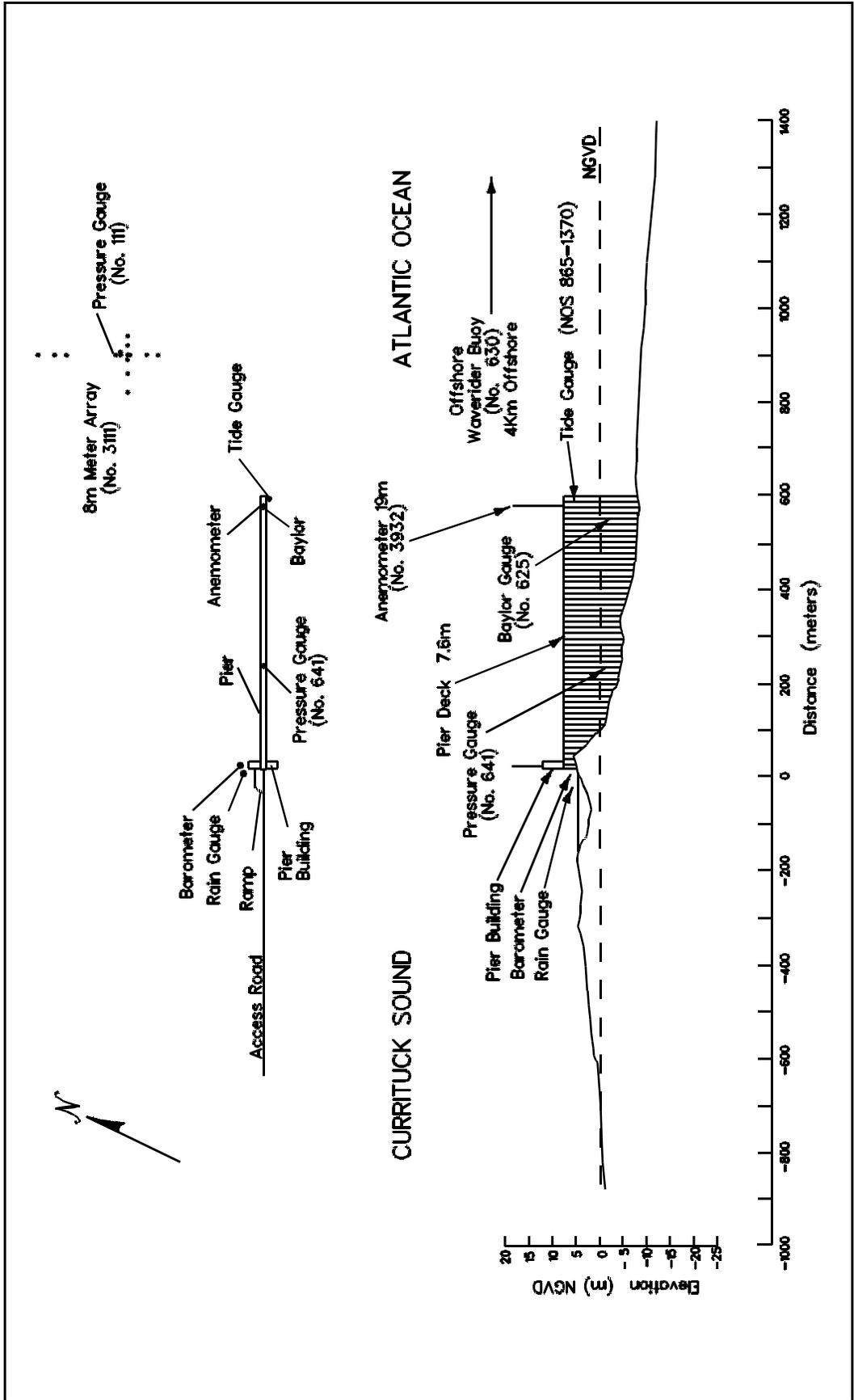


Figure 3. Instrument Locations, Elevations From NGVD

Meteorological Data

2

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -
 $\text{m/s} \times 1.943 = \text{kn}$

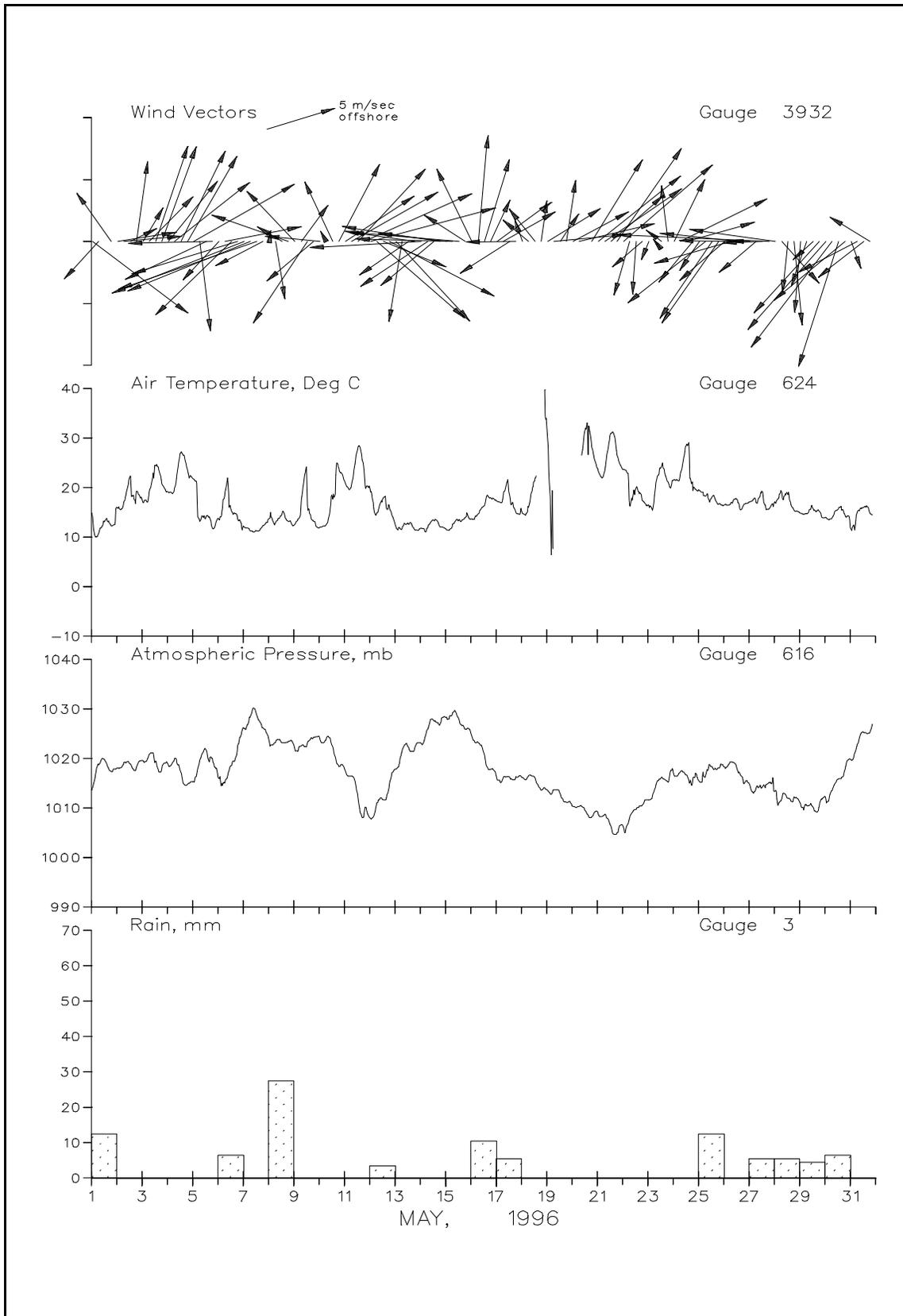


Figure 4. Meteorological Monthly Summary

**Table 3
Meteorological Data**

May 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	9	311	14.2	1014.2	0
	700	4	38	10.8	1018.8	13
	1300	Hardware Error				
2	1900	5	148	12.3	1017.4	0
	100	4	259	15.8	1018.1	0
	700	4	263	17.2	1019.3	0
	1300	2	239	22.4	1018.9	0
3	1900	7	186	19.3	1018.4	0
	100	3	207	17.0	1019.7	0
	700	5	220	19.1	1020.9	0
4	1300	8	196	24.4	1019.5	0
	1900	8	197	20.9	1018.1	0
	100	6	215	19.1	1018.7	0
	700	7	227	20.0	1020.1	0
5	1300	8	202	27.2	1017.2	0
	1900	8	206	23.5	1014.8	0
	100	8	236	21.7	1015.4	0
	700	7	354	13.2	1019.8	0
6	1300	6	61	14.3	1021.8	0
	1900	6	88	11.9	1020.0	0
	100	4	38	13.6	1016.0	0
	700	5	257	19.1	1015.4	6
7	1300	8	41	15.3	1018.6	0
	1900	8	70	13.6	1022.7	0
	100	10	65	12.1	1026.1	0
	700	9	64	11.2	1028.5	0
8	1300	10	68	11.3	1028.7	0
	1900	4	59	12.3	1026.3	0
	100	1	185	13.8	1023.2	0
	700	5	352	13.0	1023.3	28
9	1300	2	124	14.8	1023.2	0
	1900	6	112	13.2	1023.5	0
	100	5	140	12.5	1022.0	0
	700	3	212	17.7	1022.6	0
10	1300	8	29	16.5	1023.2	0
	1900	5	45	13.2	1024.4	0
	100	4	96	12.0	1023.9	0
	700	1	153	12.6	1023.9	0
10	1300	5	157	17.7	1022.5	0
	1900	7	204	24.0	1018.5	0

**Table 3
Meteorological Data (continued)**

May 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	6	232	20.9	1017.5	0
	700	7	236	20.6	1016.5	0
	1300	8	218	28.3	1012.0	0
	1900	8	242	23.3	1009.2	0
12	100	9	252	19.1	1008.0	0
	700	9	315	14.9	1011.1	4
	1300	5	1	18.0	1011.8	0
	1900	8	1	16.0	1014.9	0
13	100	8	321	12.1	1017.9	0
	700	7	8	11.8	1021.6	0
	1300	4	51	12.5	1022.3	0
	1900	5	99	11.5	1022.2	0
14	100	8	86	11.8	1023.2	0
	700	6	52	12.0	1026.0	0
	1300	5	46	13.4	1027.7	0
	1900	7	100	12.1	1027.0	0
15	100	5	98	11.5	1028.4	0
	700	7	91	12.7	1029.4	0
	1300	8	95	13.6	1027.8	0
	1900	4	126	14.0	1026.0	0
16	100	6	157	13.7	1024.6	0
	700	9	184	14.7	1023.3	10
	1300	7	194	16.4	1020.8	0
	1900	4	201	18.0	1017.9	0
17	100	5	229	17.3	1015.8	0
	700	4	236	18.5	1016.2	5
	1300	4	53	18.3	1016.3	0
	1900	3	89	15.0	1016.4	0
18	100	2	163	14.9	1016.2	0
	700	2	134	16.1	1016.7	0
	1300	3	145	22.0	1016.1	0
	1900	3	186		1013.7	0
19	100	5	234		1013.7	0
	700	5	263		1013.8	0
	1300	3	209	inoperative	1012.8	0
	1900	5	187		1011.2	0
20	100	5	238		1010.4	0
	700	5	254		1010.4	0
	1300	6	255	32.0	1009.5	0
	1900	7	207	28.2	1008.4	0

**Table 3
Meteorological Data (concluded)**

May 1996						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	8	227	23.3	1008.7	0
	700	7	231	23.5	1008.8	0
	1300	5	224	31.1	1006.4	0
	1900	9	210	26.6	1005.1	0
22	100	9	224	23.7	1006.1	0
	700	4	14	16.4	1008.1	0
	1300	4	3	20.0	1009.8	0
	1900	3	45	17.4	1010.7	0
23	100	2	19	16.4	1011.8	0
	700	0		20.0	1014.3	0
	1300	1	131	24.3	1016.3	0
	1900	5	174	21.2	1015.2	0
24	100	5	202	21.6	1016.6	0
	700	7	240	22.7	1017.3	0
	1300	5	251	28.8	1016.8	0
	1900	4	36	19.5	1016.1	0
25	100	3	30	19.5	1015.4	0
	700	7	47	18.3	1016.6	13
	1300	7	30	18.2	1018.4	0
	1900	8	30	16.7	1018.2	0
26	100	4	45	16.6	1018.4	0
	700	6	71	16.9	1019.4	0
	1300	5	97	17.5	1017.7	0
	1900	4	90	16.4	1015.0	0
27	100	1	92	17.2	1014.6	0
	700	4	46	17.0	1014.1	5
	1300	3	87	19.1	1014.4	0
	1900	11	92	15.7	1015.3	0
28	100	6	99	16.9	1013.5	0
	700	4	322	19.0	1012.1	5
	1300	4	5	18.7	1012.1	0
	1900	7	355	15.4	1012.4	0
29	100	6	4	14.8	1010.9	0
	700	4	16	14.8	1010.6	5
	1300	2	43	15.7	1010.1	0
	1900	7	38	15.3	1010.6	0
30	100	9	37	14.0	1011.8	0
	700	10	33	13.9	1013.5	6
	1300	10	15	15.9	1016.0	0
	1900	7	46	14.4	1017.9	0
31	100	2	1	11.5	1019.8	0
	700	5	59	15.1	1022.9	0
	1300	4	47	16.1	1025.3	0
	1900	3	125	14.8	1025.4	0
		Resultant		Mean	Mean	Total
		1	103	17.2	1017.4	100

Wave Data

3

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4
Wave Data**

May 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	0.35	7.4	inoperative		0.60	8.2	104	0.66	8.1
	0700	0.40	8.3			0.59	8.2	102	0.77	8.1
	1300	0.43	4.7			inoperative			0.74	8.0
	1900	0.41	8.1			0.56	8.2	100	0.65	8.1
2	0100	0.32	8.1			0.56	7.6	106	0.63	7.6
	0700	0.39	8.3			0.56	8.2	104	0.69	7.8
	1300	0.24	7.2			0.48	7.6	110	0.50	7.8
3	1900	0.32	9.2			0.48	10.8	58	0.54	7.2
	0100	0.25	7.8			0.54	6.6	110	0.57	7.4
	0700	0.33	7.8			0.48	8.2	106	0.52	7.0
4	1300	0.27	8.3			0.50	12.0	58	0.60	11.2
	1900	0.37	12.2			0.55	12.0	84	0.67	11.7
	0100	0.34	12.9			0.71	12.0	62	0.67	11.7
	0700	0.45	12.2			0.74	12.0	56	0.76	12.2
	1300	0.38	12.9			0.73	12.0	64	0.64	11.7
5	1900	0.51	12.2			0.80	12.0	78	0.88	12.2
	0100	0.40	13.5	inoperative		0.70	12.0	58	0.78	12.9
	0700	0.44	12.2			0.72	12.0	62	0.75	12.2
	1300	0.44	11.7			0.69	12.0	56	0.78	11.7
6	1900	0.47	12.2			0.71	12.0	82	0.83	12.2
	0100	0.44	4.5			0.65	12.0	54	0.76	12.2
	0700	0.32	11.2			0.54	12.0	58	0.56	11.2
	1300	0.36	11.2			0.52	10.8	58	0.68	11.2
7	1900	0.38	10.7			0.50	10.8	78	0.68	10.7
	0100	0.81	5.3			1.20	5.3	58	1.28	5.2
	0700	0.96	5.6			1.38	5.6	62	1.60	5.7
	1300	0.99	6.8			1.47	8.2	60	1.70	7.4
8	1900	0.92	7.8			1.30	8.2	62	1.45	8.1
	0100	0.69	7.8			1.10	8.2	58	1.25	7.8
	0700	0.62	5.9			1.11	6.6	60	1.11	6.6
	1300	0.54	5.7			0.92	10.8	82	1.02	6.5
9	1900	0.51	6.0			0.82	6.2	64	0.94	6.5
	0100	0.46	12.2			0.68	12.0	62	0.82	11.7
	0700	0.39	5.9			0.71	10.8	58	0.76	10.7
	1300	0.41	10.3			0.59	9.8	58	0.63	7.2
10	1900	0.49	6.1			0.72	4.4	44	0.83	4.1
	0100	0.54	4.7	inoperative		0.68	4.6	46	0.78	7.6
	0700	0.41	5.2			0.70	6.6	58	0.72	7.2
	1300	0.55	7.6			0.91	7.1	62	0.93	7.2
	1900	0.36	10.7			0.79	9.8	78	0.80	9.5

Table 4
Wave Data (continued)

May 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.39	9.9	inoperative		0.74	9.8	80	0.79	9.2
	0700	0.30	10.3			0.68	9.8	62	0.71	9.2
	1300	0.35	8.9			0.63	10.8	64	0.67	10.3
	1900	0.26	8.9			0.48	8.9	72	0.63	8.6
12	0100	0.23	8.3			0.39	8.9	104	0.62	9.2
	0700	0.23	9.2			0.35	8.9	78	0.61	3.1
	1300	0.45	5.3			0.58	5.0	30	0.70	4.9
	1900	0.40	4.8			0.45	4.4	6	0.76	5.1
13	0100	0.37	4.8			0.48	3.9	16	0.68	4.0
	0700	0.51	5.1			0.68	5.0	52	0.91	4.6
	1300	0.53	5.6			0.63	5.6	52	0.80	5.5
	1900	0.38	5.4			0.45	8.2	106	0.60	8.6
14	0100	0.45	4.0			0.61	3.9	78	0.89	3.8
	0700	0.46	4.4			0.50	8.9	102	0.75	3.9
	1300	0.32	4.1			0.45	8.9	102	0.57	4.1
	1900	0.40	3.6			0.47	3.9	94	0.66	3.5
15	0100	0.37	6.5	inoperative		0.51	7.1	86	0.75	3.9
	0700	0.49	4.5			0.67	4.4	92	0.88	4.4
	1300	0.61	4.9			0.91	4.8	82	1.03	4.8
	1900	0.52	4.7			0.70	4.8	88	0.90	4.7
16	0100	0.48	5.5			0.68	5.6	118	0.87	5.1
	0700	0.53	6.1			0.76	5.9	118	0.92	5.9
	1300	0.57	6.5			0.90	6.2	86	1.02	7.0
	1900	0.65	6.6			0.97	7.1	82	1.11	6.8
17	0100	0.51	6.6			0.82	6.6	100	0.94	6.6
	0700	0.53	6.1			0.76	9.8	70	0.88	6.1
	1300	0.34	8.9			0.66	8.9	106	0.73	8.6
	1900	0.44	9.2			0.61	8.9	82	0.73	8.6
18	0100	0.29	8.9			0.56	8.9	104	0.63	8.6
	0700	0.36	9.2			0.56	8.9	104	0.63	9.2
	1300	0.25	9.2			0.49	9.8	100	0.52	9.2
	1900	0.32	8.6			0.54	8.9	106	0.54	8.6
19	0100	0.28	8.9			0.54	8.9	82	0.58	9.5
	0700	0.34	8.1			0.59	8.9	74	0.62	8.9
	1300	0.26	9.5			0.56	8.2	82	0.55	8.9
	1900	0.32	9.2			0.53	8.9	78	0.59	9.2
20	0100	0.24	9.2	inoperative		0.51	8.9	102	0.52	9.5
	0700	0.29	13.5			0.52	12.0	58	0.51	8.6
	1300	0.27	12.9			0.54	12.0	54	0.55	12.9
	1900	0.35	12.2			0.57	12.0	58	0.66	12.9

Table 4
Wave Data (concluded)

May 1996										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
21	0100	0.28	12.9	inoperative		0.57	12.0	62	0.59	12.2
	0700	0.25	12.2			0.53	12.0	52	0.51	11.2
	1300	0.23	11.7			0.49	12.0	56	0.55	12.2
	1900	0.28	12.2			0.47	12.0	52	0.56	11.7
22	0100	0.22	12.2			0.41	12.0	86	0.51	12.2
	0700	0.25	11.7			0.44	12.0	60	0.48	11.7
	1300	0.28	11.7			0.38	12.0	86	0.51	11.7
	1900	0.22	10.7			0.29	10.8	54	0.41	11.2
23	0100	0.21	10.7			0.29	10.8	56	0.39	10.7
	0700	0.22	6.3			0.34	10.8	86	0.38	10.7
	1300	0.21	6.1			0.34	10.8	56	0.38	7.2
	1900	0.22	6.3			0.38	6.6	100	0.42	6.6
24	0100	0.32	7.2			0.47	6.6	106	0.53	6.3
	0700	0.30	9.5			0.50	8.9	92	0.56	9.5
	1300	0.32	8.6			0.43	8.9	108	0.50	8.9
	1900	0.24	8.3			0.37	8.2	110	0.44	8.9
25	0100	0.25	8.3	inoperative		0.34	8.9	104	0.37	8.9
	0700	0.31	2.8			0.34	8.9	104	0.55	3.1
	1300	0.68	4.5			0.88	4.6	60	1.01	4.7
	1900	0.76	5.7			0.91	4.8	18	1.13	4.9
26	0100	0.66	6.3			0.79	6.6	48	0.87	6.8
	0700	0.51	6.1			0.67	6.2	40	0.82	5.7
	1300	0.58	5.3			0.73	5.3	38	0.93	5.2
	1900	0.41	4.5			0.60	5.3	84	0.67	7.4
27	0100	0.39	5.0			0.57	7.1	82	0.67	6.0
	0700	0.29	5.7			0.55	7.6	86	0.57	5.3
	1300	0.38	4.6			0.69	5.6	54	0.70	5.5
	1900	0.93	5.9			1.37	5.9	44	1.50	5.6
28	0100	0.82	7.2			1.27	7.1	70	1.36	6.6
	0700	0.55	7.6			0.96	7.6	64	1.07	7.8
	1300	0.92	9.9			1.37	9.8	60	1.33	8.6
	1900	0.89	8.9			1.30	9.8	60	1.42	8.3
29	0100	0.87	8.3			1.33	8.9	72	1.29	8.1
	0700	0.68	8.3			0.96	8.9	60	1.12	7.0
	1300	0.48	8.3			0.84	7.6	62	0.82	8.1
	1900	0.55	10.3			0.92	8.9	60	0.91	9.2
30	0100	0.79	5.5	inoperative		1.15	5.6	56	1.35	5.6
	0700	0.84	5.0			1.08	5.0	50	1.28	5.1
	1300	0.79	5.1			1.07	5.3	62	1.33	4.9
	1900	0.71	5.5			0.97	5.6	60	1.13	5.6
31	0100	0.55	5.4			0.83	5.9	56	0.91	6.3
	0700	0.52	6.5			0.73	9.8	58	0.79	6.3
	1300	0.45	9.5			0.78	8.9	58	0.86	8.3
	1900	0.46	9.9			0.70	8.9	80	0.80	8.6
Mean		0.45	8.0	0.00	0.0	0.69	8.5	72	0.78	8.0
Std dev		0.19	2.7	0.00	0.0	0.26	2.5	23	0.27	2.6

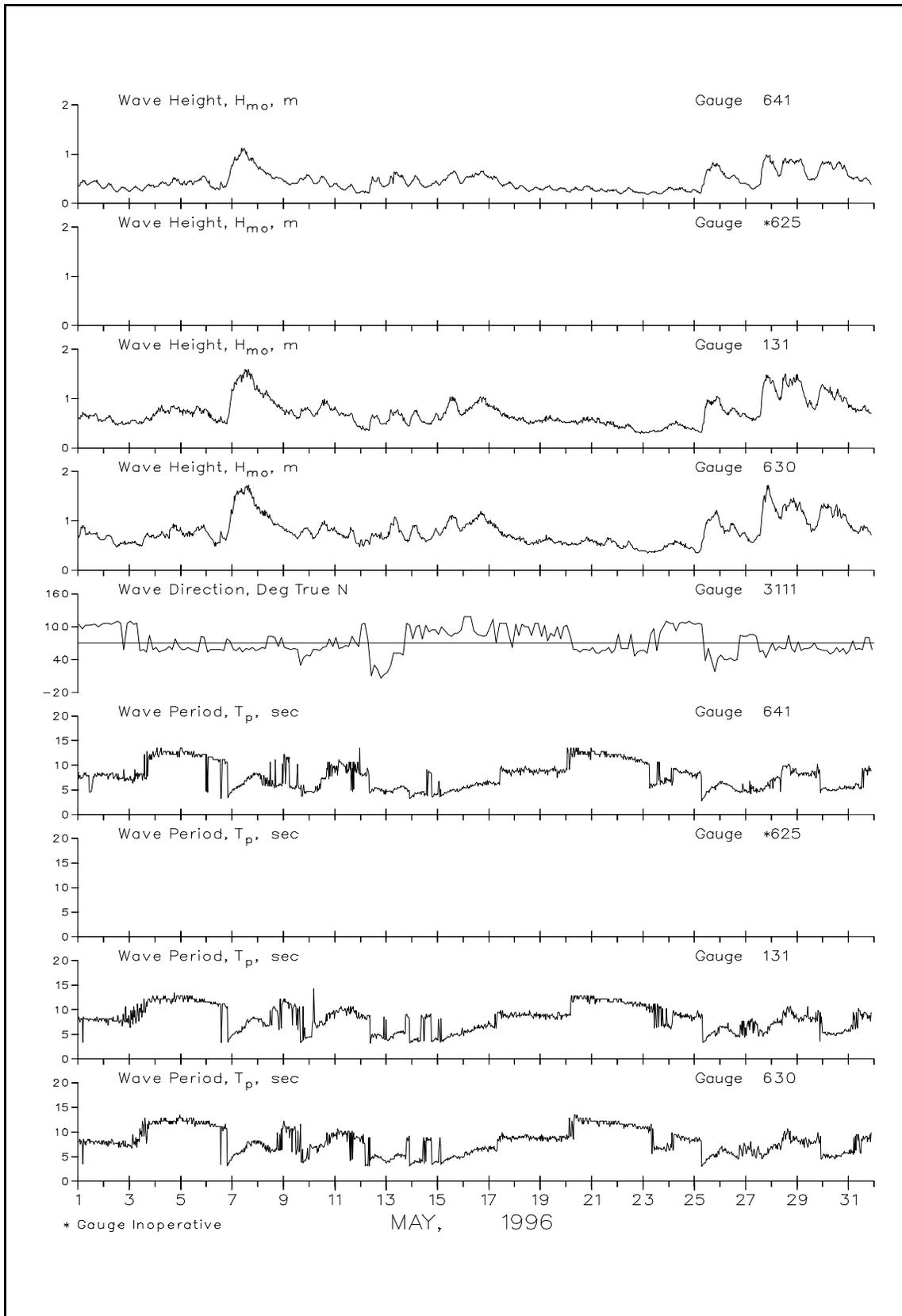


Figure 5. Wave Heights and Periods

Current Data

4

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

MAY 1996																	
Cross Long					Cross Long					Cross Long							
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100	0	-6	7	340	1300	0	-8	9	337	22	100	1	-1	2	306	
	700	-1	4	4	135	1900	3	-4	6	308		700	0	0	0		
	1300	-1	-1	2	25	12	100	4	-11	13	323	1300	-2	1	3	100	
	1900	0	0	0			700	-1	7	8	144	1900	2	-2	4	299	
2	100	0	-4	5	351	1300	0	-1	2	355	23	100	0	1	1	125	
	700	-1	-2	4	11	1900	4	-3	6	295		700	-4	22	22	146	
	1300	0	-4	6	351	13	100	-2	-6	7	4	1300	-2	10	10	146	
	1900	1	0	1	245	700	-9	22	24	137	1900	0	5	5	150		
3	100	0	-1	2	17	1300	-6	25	26	144	24	100	-1	0	2	38	
	700	0	-1	2	10	1900	-7	12	14	128		700	0	-5	6	343	
	1300	0	-3	4	341	14	100	-5	16	17	141	1300	-5	0	6	63	
	1900	1	-12	13	334	700	-3	12	13	142	1900	1	0	2	289		
4	100	2	-6	7	325	1300	-3	10	11	137	25	100	0	0	0		
	700	2	-9	10	329	1900	-6	10	12	126		700	0	2	2	166	
	1300	1	-5	6	328	15	100	0	10	10	157	1300	-4	14	15	140	
	1900	0	-13	14	339	700	-2	5	5	132	1900	-8	13	15	125		
5	100	3	-3	5	304	1300	0	7	7	155	26	100	-8	28	29	142	
	700	0	-5	7	352	1900	-1	4	4	138		700	-5	9	11	125	
	1300	-2	1	3	92	16	100	0	2	3	138	1300	-2	2	4	105	
	1900	-4	-10	12	3	700	0	0	0		1900	-6	-5	9	27		
6	100	-1	-4	6	357	1300	3	-8	10	325	27	100	-2	3	4	118	
	700	2	-11	12	332	1900	2	-3	5	312		700	-6	20	21	141	
	1300	-3	1	4	92	17	100	1	-2	3	330	1300	1	15	15	165	
	1900	0	6	6	149	700	1	1	2	201	1900	-4	1	5	76		
7	100	-5	22	23	145	1300	0	0	0		28	100	0	11	11	154	
	700	-7	21	22	139	1900	0	-4	5	343		700	-2	6	6	137	
	1300	-5	29	29	148	18	100	-1	3	4	126	1300	-4	12	13	137	
	1900					700	0	0	0		1900	-3	23	23	151		
8	100				inoperative	1300	-3	22	22	149	29	100	-3	16	17	148	
	700					1900	0	2	2	150		700	-8	12	15	124	
	1300	0	13	13	154	19	100	-2	8	8	141	1300	-6	14	16	134	
	1900	-1	-1	2	31	700	0	8	8	156	1900	-3	13	14	142		
9	100	0	-1	2	354	1300	-4	8	9	129	30	100	1	17	17	163	
	700	0	0	0		1900	-1	2	3	119		700	-1	10	10	148	
	1300	-1	1	2	85	20	100	-1	2	2	114	1300	-5	16	17	139	
	1900	-7	17	19	134	700	-1	0	2	45	1900	-2	13	14	148		
10	100				inoperative	1300	-2	2	3	113	31	100	-6	12	14	131	
	700	-2	16	16	148	1900	0	2	2	135		700	0	-1	2	358	
	1300	-3	9	10	135	21	100	0	-3	4	341	1300	0	0	0		
	1900	1	3	3	179	700				inoperative	1900	0	15	15	155		
11	100	0	1	1	148	1300	-1	1	2	86							
	700	0	0	0		1900	0	-4	5	337							

KEY:
 +cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

May 1996												
Day	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	-2	15	15	166	-5	12	13	250	North	15	N	
2	9	-6	10	38	1	-8	8	349	South	20	N	
3	7	-11	13	11	5	-17	18	357	South	15	N	
4	9	-23	25	2	6	-14	15	2	South	14	N	
5	0	8	8	157	0	18	18	160	North	9	N	
6	12	-16	20	17	0	-15	15	340	South	4	N	
7	-6	38	39	169	-5	51	51	166	North	41	N	
8	2	36	36	157	5	36	36	151	North	27	N	
9	-1	-6	6	331	2	-34	34	343	South	32	S	
10	-2	20	20	166	-2	12	12	250	North	21	N	
11	17	-12	21	36	6	-15	16	2	South	12	N	
12	8	34	35	146	3	28	28	154	North	0		
13	-8	32	33	174	-4	29	29	169	North	21	N	
14	-3	34	34	166	-30	51	59	191	no observation			
15	-15	-12	19	290	-8	-20	21	318	no observation			
16	6	-12	14	7	10	-41	42	354	no observation			
17	25	25	36	115	-23	-47	52	313	South	9	N	
18	0	55	55	160	0	10	10	160	North	30	N	
19	15	10	17	104	-7	15	17	250	North	15	N	
20	15	15	22	70	5	10	11	70	South	0		
21	20	-41	45	7	-7	-34	35	329	North	5	S	
22	8	9	12	120	5	7	8	70	North	6	S	
23	-3	61	61	163	0	38	38	160	North	21	N	
24	14	-14	20	25	9	-18	21	7	South	46	N	
25	-7	9	12	197	-7	12	15	191	North	26	N	
26	-5	12	13	184	-3	7	7	187	North	18	N	
27	-4	5	6	250	-2	6	6	174	North	8	N	
28	2	15	15	151	-2	23	24	166	North	9	N	
29	1	21	21	157	0	34	34	160	North	30	N	
30	-12	47	48	174	0	34	34	160	North	70	S	
31	-4	38	38	166	0	34	34	160	North	43	N	

KEY:
+cross-shore = offshore, cm/sec
-cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec
Dir = Resultant direction, degrees true north

Visual Observations

5

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

May 1996

Day	Time	Wave Approach Angle at Pier End deg from True N		Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary		Temp.,C	Density g/cc	Secchi Vis.,m
1	0630	40		40	11.1	1.0257	2.4
2	0545	95		43	11.1	1.0258	1.8
3	0600	105		18	12.2	1.0258	1.8
4	0700	130		23	10.8	1.0256	2.1
5	0655	55		30	10.6	1.0265	0.9
6	0615	100	135	23	14.2	1.0255	2.1
7	0640	60		200	14.4	1.0223	1.2
8	0630	65	25	162	14.2	1.0209	0.9
9	0530	80		26	15.0	1.0202	1.5
10	0615	70		26	15.0	1.0201	2.1
11	0745	70	150	20	13.6	1.0227	1.5
12	0645	150		20	12.8	1.0253	2.7
13	0550	25		29	13.3	1.0250	2.7
14	0550	55		37	15.0	1.0184	2.1
15	0700	100	50	34	15.0	1.0188	2.7
16	0700	100	140	30	14.4	1.0234	2.7
17	0734	105	80	27	14.4	1.0240	2.7
18	0815	100		21	16.4	1.0170	2.1
19	0730	100		35	14.4	1.0222	2.4
20	0540	140	100	35	15.0	1.0220	1.8
21	0702	75		15	13.9	1.0250	2.4
22	0540	130	90	23	14.2	1.0261	2.4
23	0600	110		30	19.4	1.0180	2.7
24	0645	120		23	18.3	1.0218	2.1
25	0640	35		20	20.0	1.0207	2.7
26	0620	45		37	20.3	1.0156	2.7
27	0730	50		32	20.3	1.0143	3.0
28	0635	60		139	20.0	1.0169	3.0
29	0540	55		160	19.2	1.0156	1.8
30	0615	55		143	17.5	1.0182	1.8
31	0515	60		32	16.9	1.0181	2.1

Water Levels

6

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

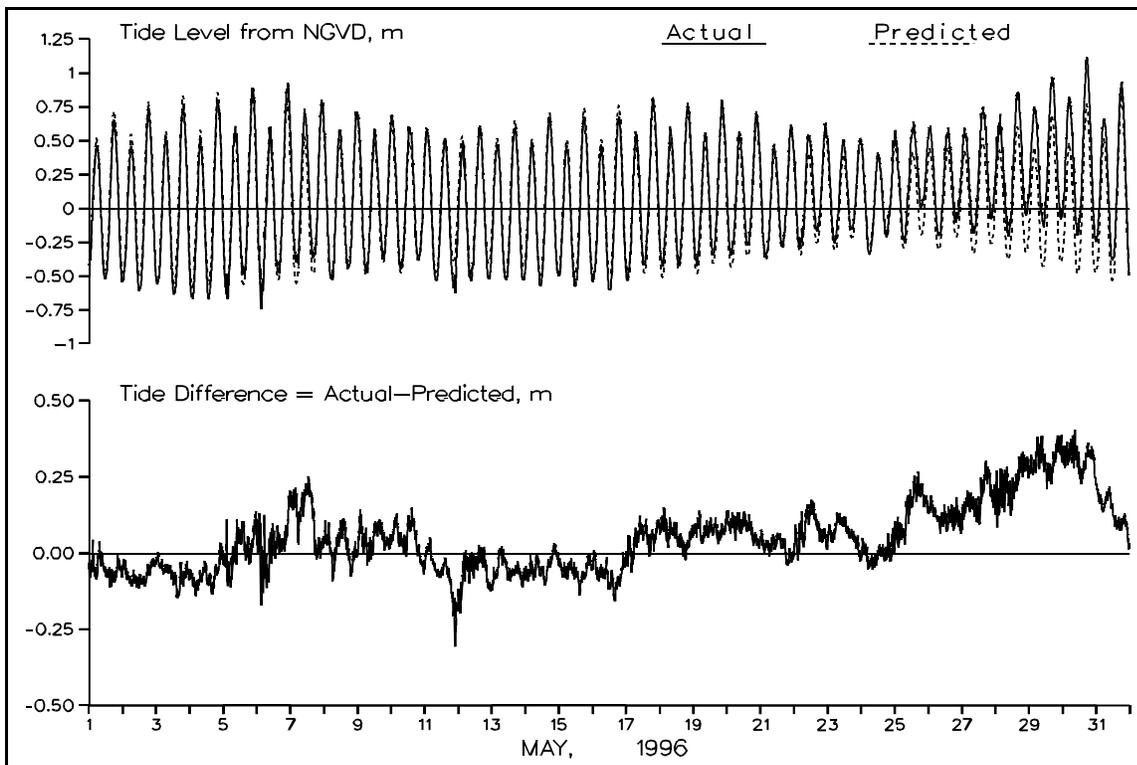


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

MAY 1996 Tide Levels															
Day	High		Day	Low		Mean	Range	Day	High		Day	Low		Mean	Range
	Time	m		Time	m				m	m		Time	m		
1	0618	0.47	1	0000	-0.45	0.14	0.92	16	1836	0.68	16	1236	-0.60	0.05	1.28
1	1742	0.65	1	1124	-0.52	0.07	1.18	17	0630	0.57	17	0030	-0.53	0.02	1.10
2	0606	0.46	1	2342	-0.54	-0.03	1.00	17	1906	0.82	17	1254	-0.41	0.20	1.23
2	1824	0.75	2	1142	-0.61	0.06	1.36	18	0724	0.60	18	0200	-0.43	0.08	1.03
3	0642	0.53	3	0042	-0.56	-0.02	1.09	18	2006	0.78	18	1336	-0.42	0.18	1.20
3	1936	0.77	3	1230	-0.64	0.06	1.40	19	0824	0.56	19	0218	-0.43	0.08	0.98
4	0718	0.52	4	0206	-0.67	-0.07	1.19	19	2024	0.80	19	1400	-0.35	0.23	1.14
4	2018	0.80	4	1330	-0.67	0.09	1.47	20	0854	0.57	20	0230	-0.35	0.11	0.92
5	0830	0.61	5	0248	-0.67	-0.01	1.28	20	2048	0.71	20	1500	-0.28	0.21	0.99
5	2030	0.89	5	1506	-0.49	0.19	1.38	21	0948	0.48	21	0348	-0.36	0.05	0.84
6	0924	0.60	6	0254	-0.74	0.00	1.35	21	2142	0.62	21	1536	-0.28	0.16	0.90
6	2206	0.93	6	1554	-0.48	0.21	1.41	22	1000	0.54	22	0424	-0.30	0.13	0.84
7	1006	0.74	7	0518	-0.41	0.16	1.14	22	2218	0.63	22	1636	-0.17	0.22	0.80
7	2218	0.80	7	1612	-0.37	0.20	1.17	23	1136	0.51	23	0442	-0.25	0.14	0.76
8	1136	0.58	8	0606	-0.53	0.04	1.11	23	2248	0.51	23	1642	-0.16	0.18	0.67
8	2306	0.71	8	1700	-0.44	0.15	1.16	24	1148	0.41	24	0548	-0.34	0.04	0.75
9	1142	0.59	9	0654	-0.48	0.06	1.07	25	0018	0.58	24	1800	-0.21	0.17	0.79
10	0018	0.69	9	1830	-0.36	0.18	1.05	25	1318	0.64	25	0700	-0.26	0.22	0.90
10	1230	0.60	10	0636	-0.44	0.09	1.05	26	0130	0.61	25	1824	0.01	0.30	0.60
11	0118	0.59	10	1900	-0.38	0.10	0.98	26	1412	0.60	26	0718	-0.20	0.20	0.80
11	1412	0.51	11	0824	-0.54	-0.01	1.05	27	0148	0.59	26	1924	-0.10	0.24	0.70
12	0318	0.49	11	2136	-0.63	-0.04	1.12	27	1500	0.75	27	0830	-0.19	0.29	0.94
12	1524	0.61	12	0854	-0.54	0.04	1.15	28	0306	0.69	27	2054	-0.08	0.29	0.77
13	0418	0.47	12	2154	-0.52	0.00	1.00	28	1554	0.86	28	0912	-0.21	0.34	1.07
13	1624	0.60	13	1006	-0.53	0.03	1.13	29	0324	0.75	28	2142	-0.05	0.36	0.81
14	0418	0.48	13	2206	-0.53	-0.02	1.01	29	1554	0.97	29	1012	-0.14	0.43	1.11
14	1700	0.68	14	1036	-0.57	0.06	1.25	30	0424	0.82	29	2236	-0.08	0.38	0.90
15	0518	0.47	15	0006	-0.50	-0.02	0.97	30	1712	1.11	30	1030	-0.20	0.45	1.31
15	1748	0.68	15	1136	-0.57	0.05	1.25	31	0536	0.67	30	2342	-0.25	0.23	0.91
16	0606	0.47	16	0000	-0.54	-0.04	1.01	31	1806	0.94	31	1124	-0.38	0.27	1.32

Bathymetry

7

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in April 1996 and the survey(s) in May 1996 on profile line 188, located 517 m south of the pier.

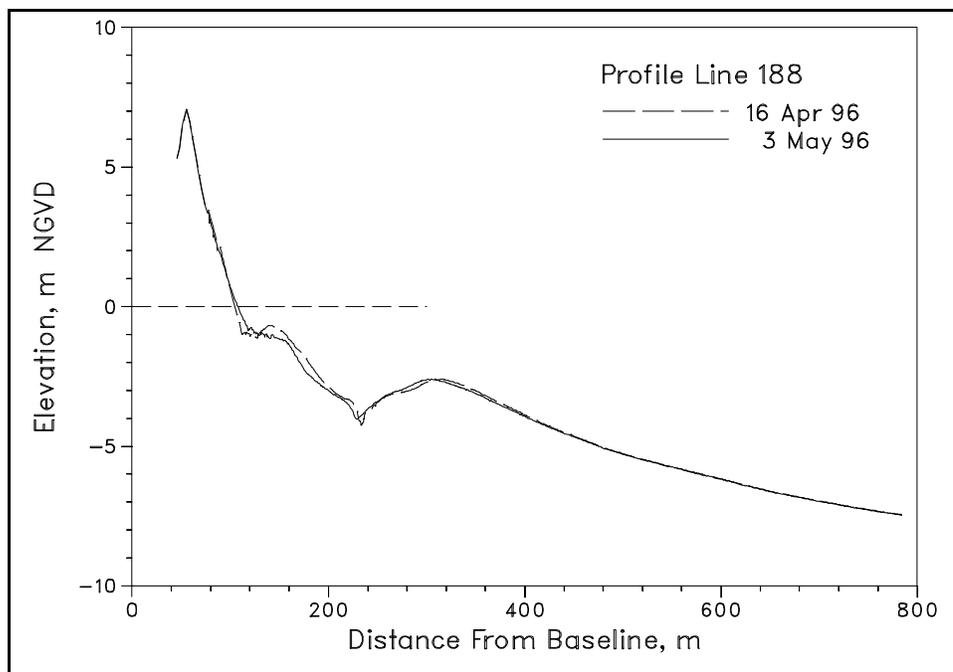


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1996. Cross-hatched areas indicate changes to the annual envelope which occurred in May.

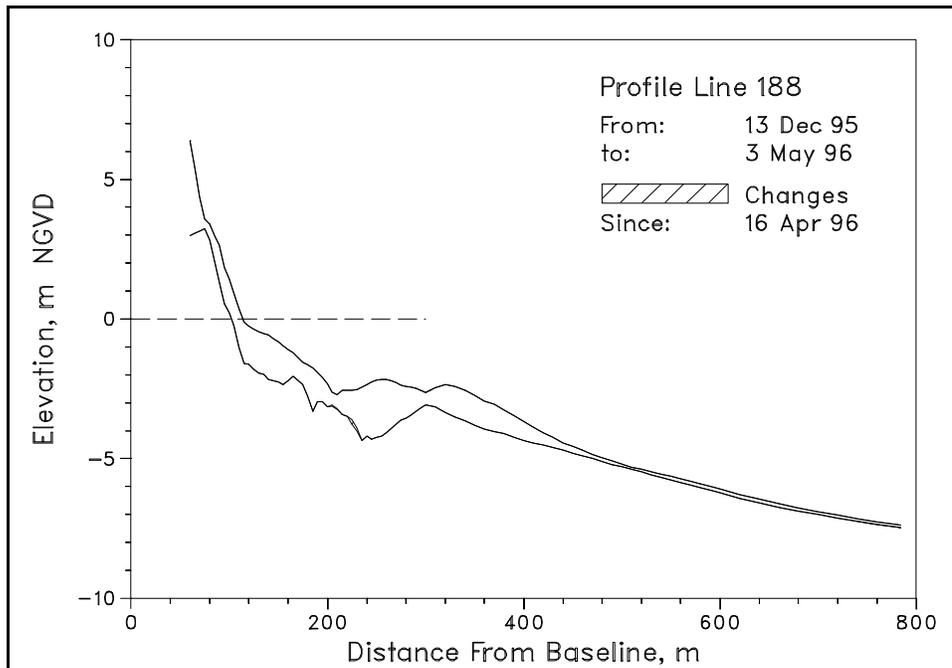
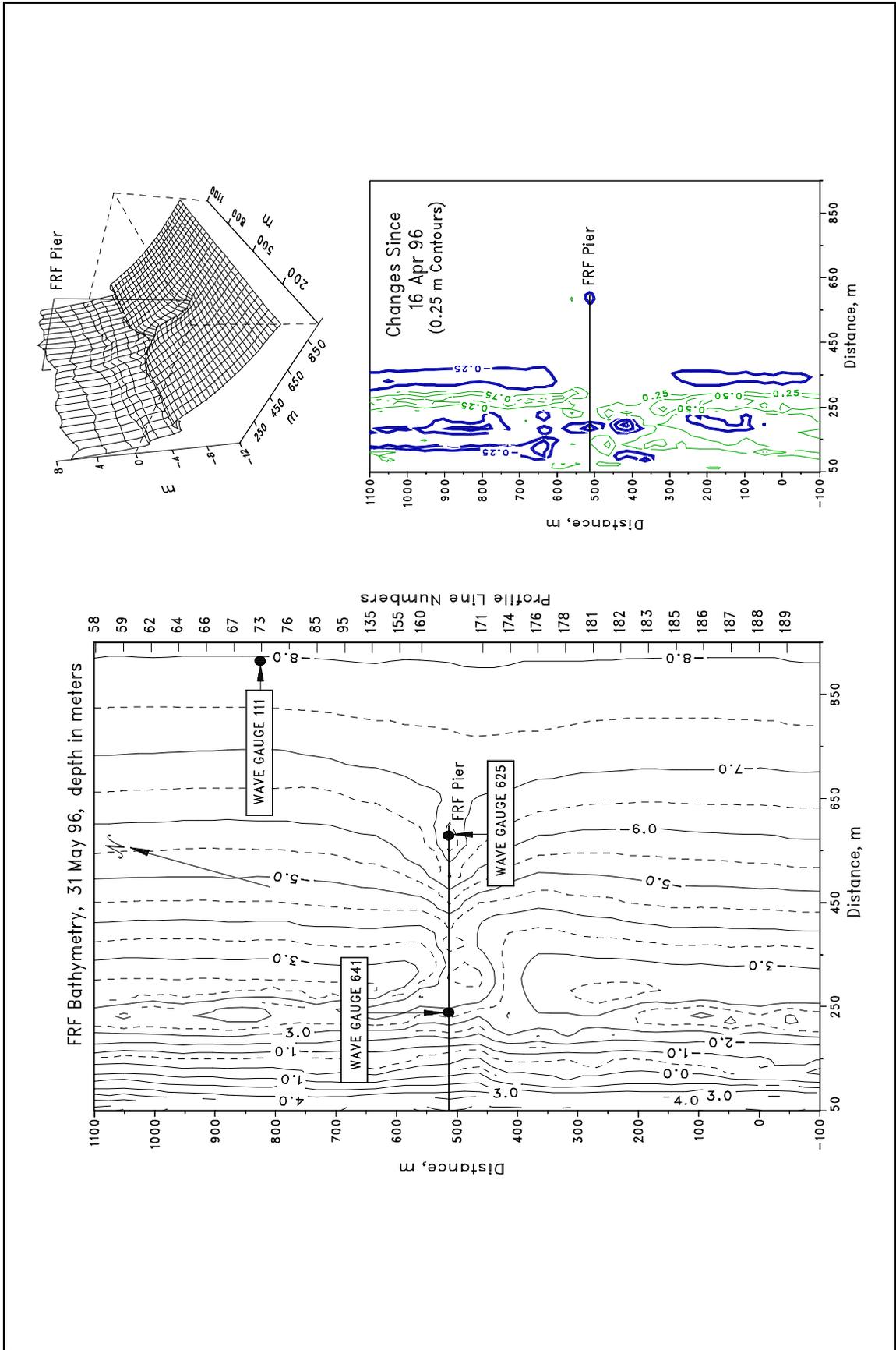


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 31 May. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.



Special Events

8

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
** Dec (0000)	** Dec (0000)

B. Storm Synopsis.

Northeasterly winds were funneled between a Canadian high pressure system and a low pressure system over Cape Hatteras. Winds intensified as the low pressure system moved along the North Carolina coast and began moving out to sea by the morning of ** May. Maximum onshore winds (NE) reached ** m/s at 0000 EST on ** May. The minimum atmospheric pressure was *** mb. The maximum H_{mo} , at gauge 630, reached *.* m ($T_p=**.*$ s) at 0000 EST on ** May. There was * mm of precipitation.